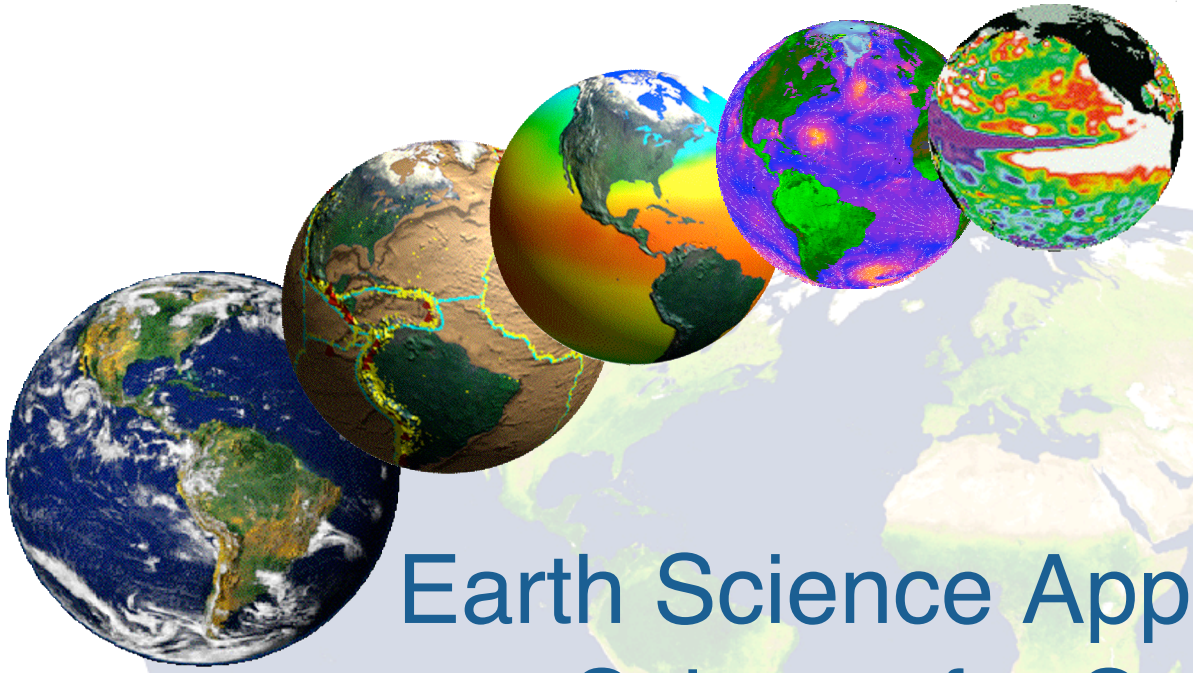
ESSAAC Briefing



Earth Science Applications: Science for Society

July 17, 2003

Ronald J. Birk
Director, Applications Division
NASA Office of Earth Science

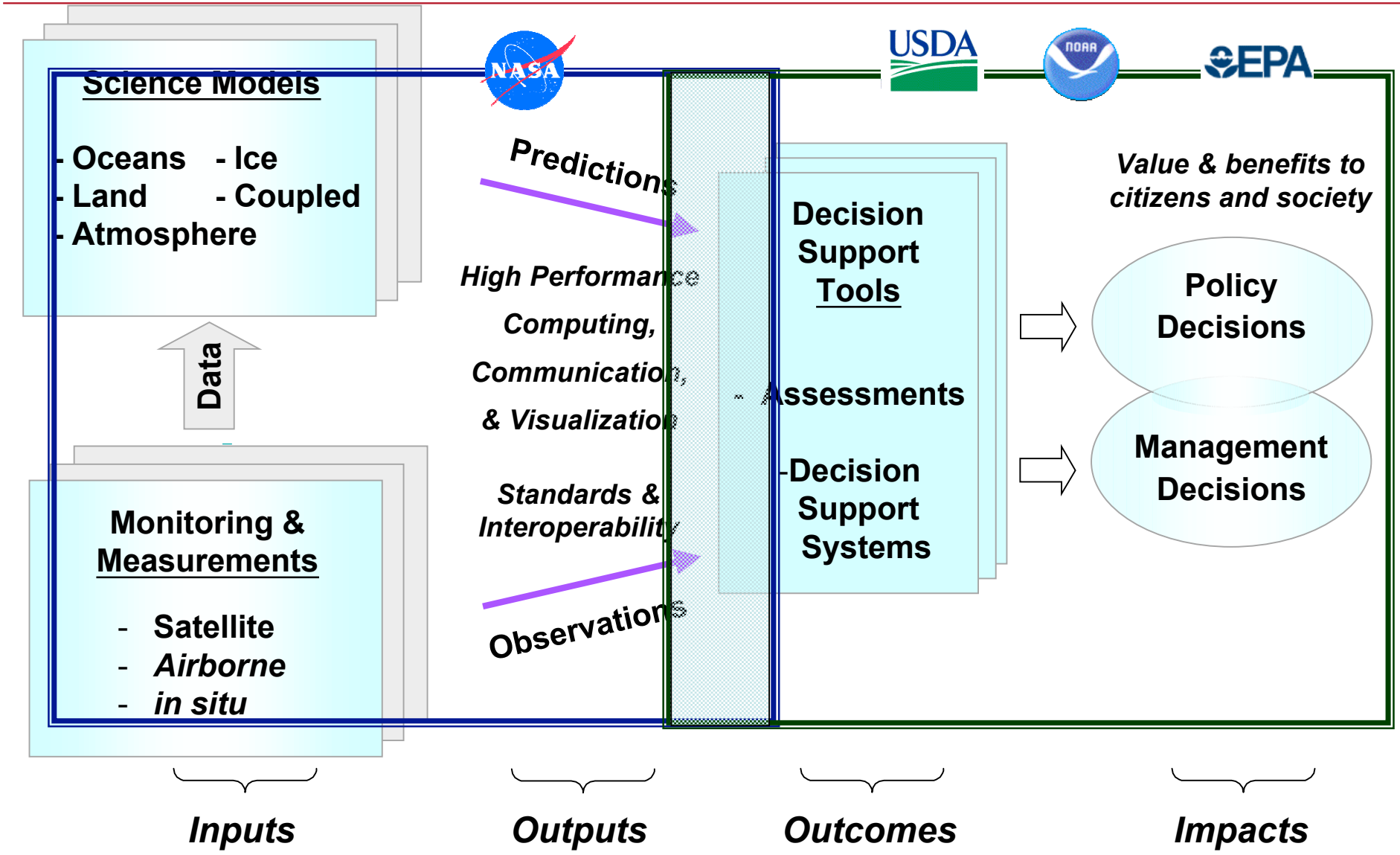
Statement of Purpose & Mission

NASA Earth Science Enterprise Applications

- conducts research and development of aerospace science and technology
- to increase knowledge of the Earth system
- to improve decision support tools to serve society with improved predictions and decreased uncertainty

Earth Science Applications has a mission to "accelerate the realization of economic and societal benefits from Earth science, information, and technology …"

Integrated System Solutions



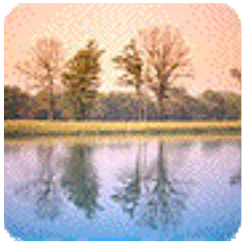
Applications of National Priority

Carbon Management

Public Health

Energy Forecasting

Aviation Safety



Water Management

Homeland Security

Coastal Management

Disaster Management

Agricultural Efficiency

Invasive Species

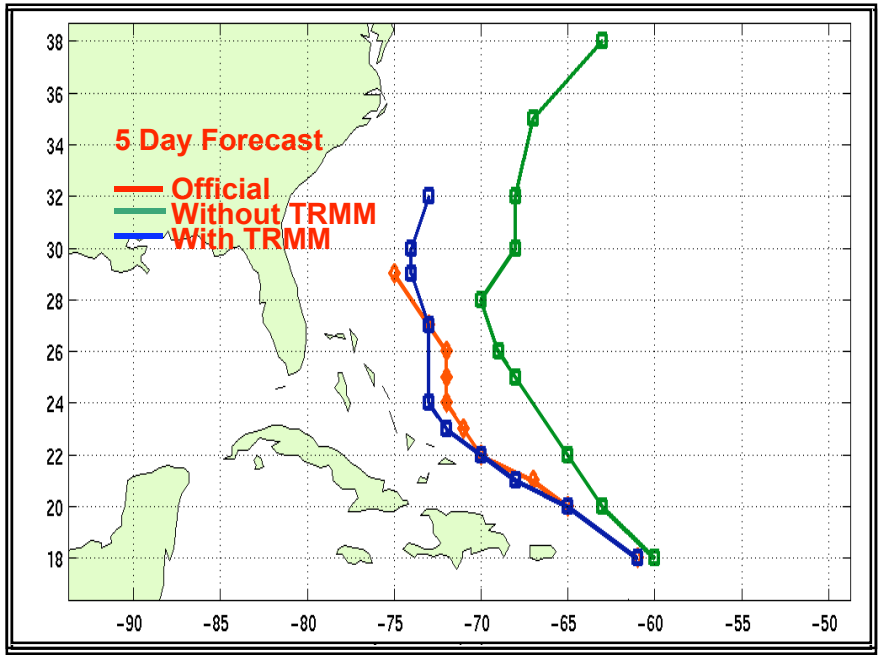
Community Growth

Air Quality

Improving Hurricane Track Forecasts

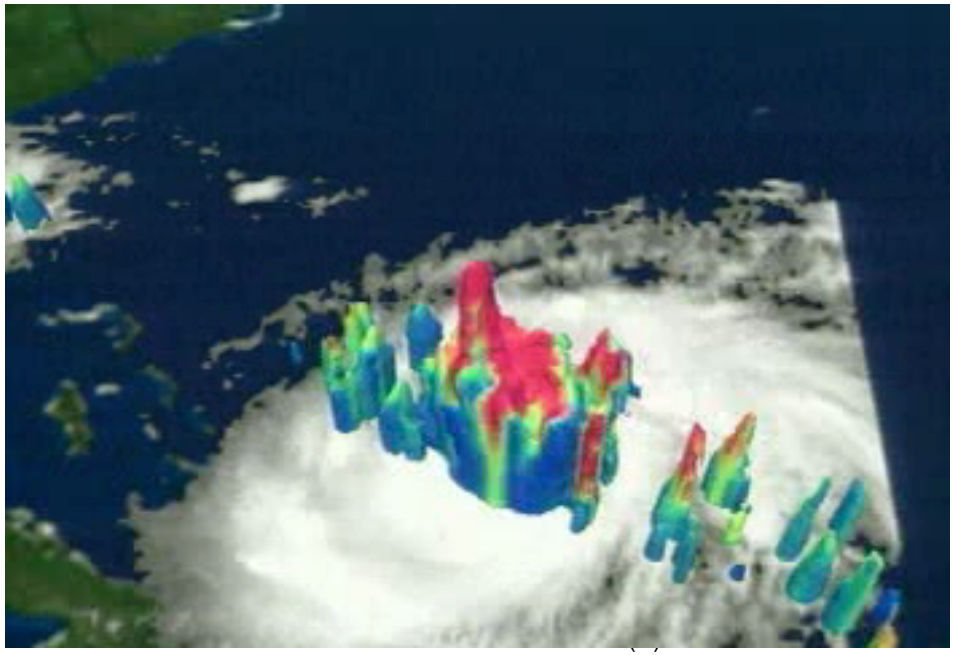
Assimilation of TRMM rainfall location, intensity and vertical structure into hurricane forecast models leads to improvements in forecasts of future position

Hurricane Bonnie, Atlantic, Aug 1998



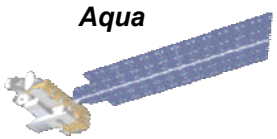
Dr. A. Hou, NASA DAO

Hurricane Visualization with TRMM data



Reduced track errors can save money ($600K - $1M per mile of coast evacuated) and save lives by more precise prediction of eye location at landfall

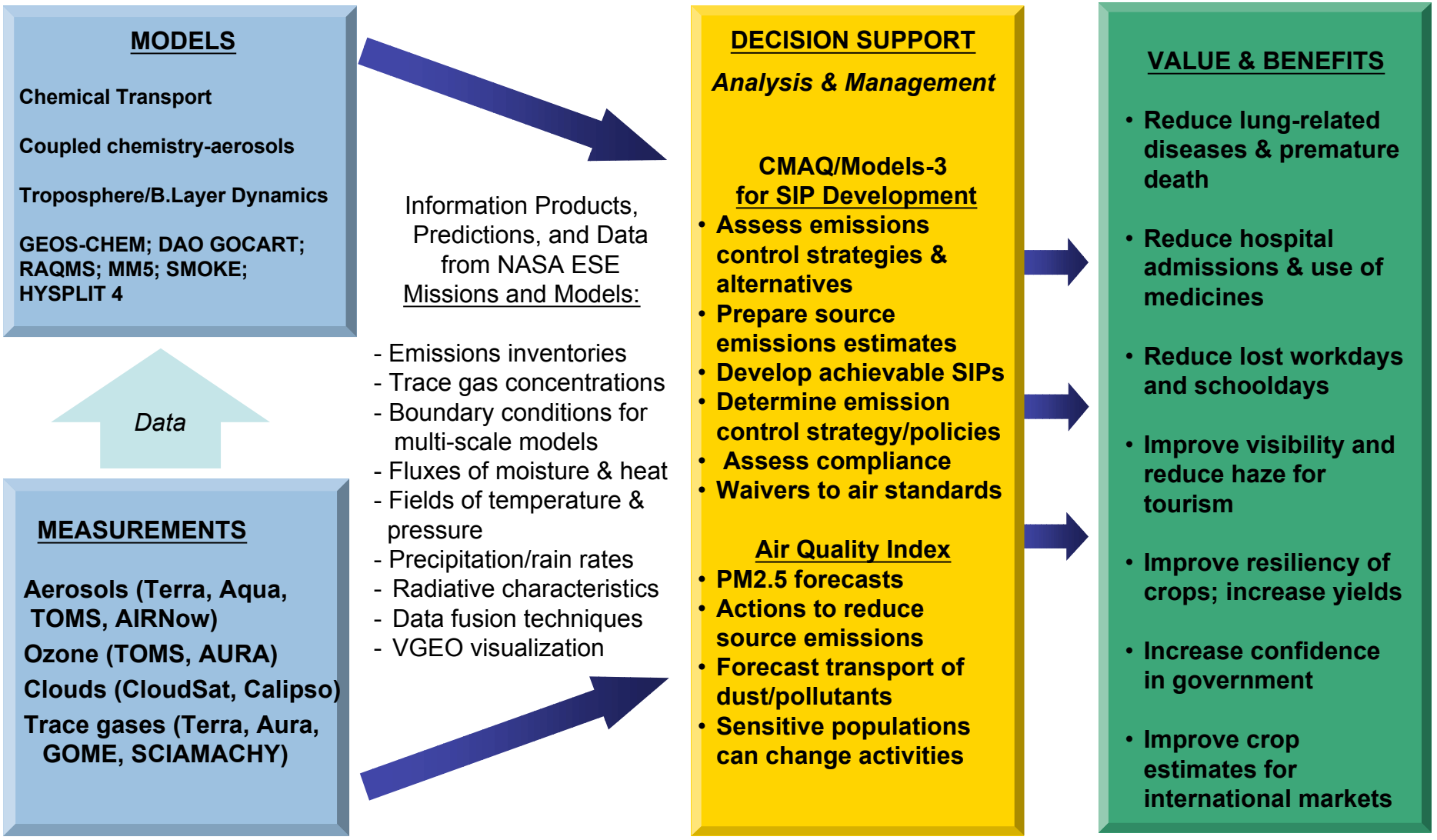
Air Quality Index: Optical Depth



- EPA is evaluating NASA research results to benchmark performance enhancements to their Air Quality Index and forecasts
- Evaluations of optical depth derived from MODIS supporting assessments for PM2.5 transport rule making and Clear Skies
- Potential for EPA ground sites to support NASA INTEX field campaign

NASA & EPA Collaboration on Air Quality

Air Quality: Integrated Solution



Air Quality Management:
Clean Air Standards and Air Quality Forecasts

June 17, 2003
L. Freidl

State 2- ESMF (c. 2015):
- **Robust emissions control planning**
- **Routine warnings of pollution events**
- **Multple-day air quality forecasts**

Socioeconomic Impact

Simultaneous high-time & space resolved pollutants (O3, CO, NOx, SO2, HCHO, aerosols); local resolution in boundary layer. Nighttime chemistry & transport. Feedbacks betw. aerosols, O3, H20, climate. Chem-radiation coupling in GCMs. Quantify LRT in regional pollution.

Accurate pollution forecasts updated regularly within day. Reduced hospital visits from extreme events. Improved NAAQS planning - fewer non-attainment areas. Insight on mobile emission fluctuations. Advanced, targeted mitigation of impacts from severe episodes.

NPP-NPOESS - ozone trend & aerosols. Feedbacks between O3, H2O, and aerosols. Global trop. winds. Geographic evol. of trop. O3 & aerosols. Lightning NOx emission inventories. Trop. mixing & BL interaction. Urban-scale heat flux. High-res. soundings.

Clear Skies NOx/SO2 Trading Program. Longer lead-time on source & destination of ozone and aerosols. Alerts to re-route airplanes. Alerts to hospitals to expect specific symptoms. Ozone attainment areas. Potential EPA SIP credits for heat island reduction approaches & corresponding state/city policies.

CloudSat & CALIPSO - cloud profiles. Accurate energy & water in MM5. Vertical levels in lower troposphere. Models incorporate radiative forcings. Land-atmos. interactions. Chemistry-transport models. Stratospheric/trop. coupling. Chemistry-climate interactions.

Forecasts of beginning & length of annual "pollution season." Improvements from achievable SIPs - reduced haze, improved visibility in parks, cleaner water, healthier forest ecosystems, reduced lost work/school days. Support US treaty on long-range transport of organic pollutants.

AURA - SO2, NOx, NH3 and aerosol products & IMPROVE network. INTEX-West. NH3 emissions factors; air dispersion models (NOx, CO, PM); MM5 & assimilation of surface moisture, heat capacity, insolation. Nested model developments. RAQMS & DAS for daily 3-D ozone.

Support for goals of Clear Skies initiative. Science-based attribution of source emissions. States quantify voluntary stationary emission reductions within 18 months. Heat island effects in local weather and air quality forecasts. Longer-term AQI forecasts. UV-B notice.

AURA - AURA - AURA. Trop. residuals (O3, NO2, SO2, HCHO); NRT NOx & VOC emission inventories (top-down/bottom-up) for CMAQ & ozone precursors; O3 assimilations in CMAQ; 3-D global trop. chemistry in GEOS-CHEM; aerosol pattern rendering.

Support 2004 NOx SIP call. State justify & EPA corroborates claims for foreign-born pollution waivers. Annual EPA analysis of worst 20 pollution events for trends. Extend PM/O3 forecasting to rural areas - warnings to farmers. Targeted mitigation approaches. Ozone loops in EPA's AQI.

INTEX continental inflow-outflow; ICESat - vertical distribution of dust & clouds; ASTER urban heat flux; Global-to-regional RAQMS - prototype BCs in CMAQ; DAS nested GCM to 0.5º grid. Pollution trajectories & BL deposition of LRT of aerosols. PM network.

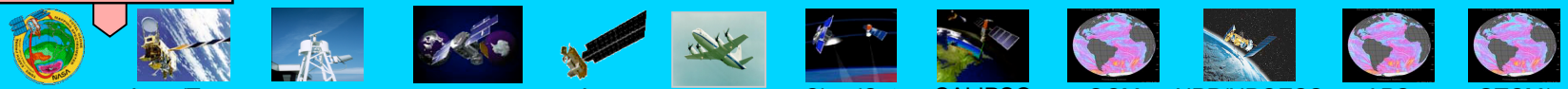
States assess emissions control options, development options &emissions strategies to build attainable SIPs. Achievable SIPs improve air quality, public health & economic development opportunities. Urban health alerts for temperature-induced pollution events. EPA guidebook on heat island reduction approaches. States claim waivers for foreign-born pollutants.

MODIS AOD, MOPITT CO, TOMS ozone residuals - correlate to EPA ground measures. Large scale transport of aerosols. GOCART assimilations for B.C.s in models. NRT MODIS-TEOM data fusion.

Policy-Forecasts-Health-Economics. Aerosol transport loops in EPA Air Quality Index (AQI) for regional forecasts. Improved siting for surface monitoring network locations. Support EPA-developed tools for state/locals on regional haze. Evaluate exceptional events for effects on NAAQS violations. EPA PM transport rule making.

State 1-CMAQ & AQI (c. 2003)

Improved capabilities to air quality managers to assess, plan & implement sound-science, emissions control strategies, policy, & air quality forecasts.

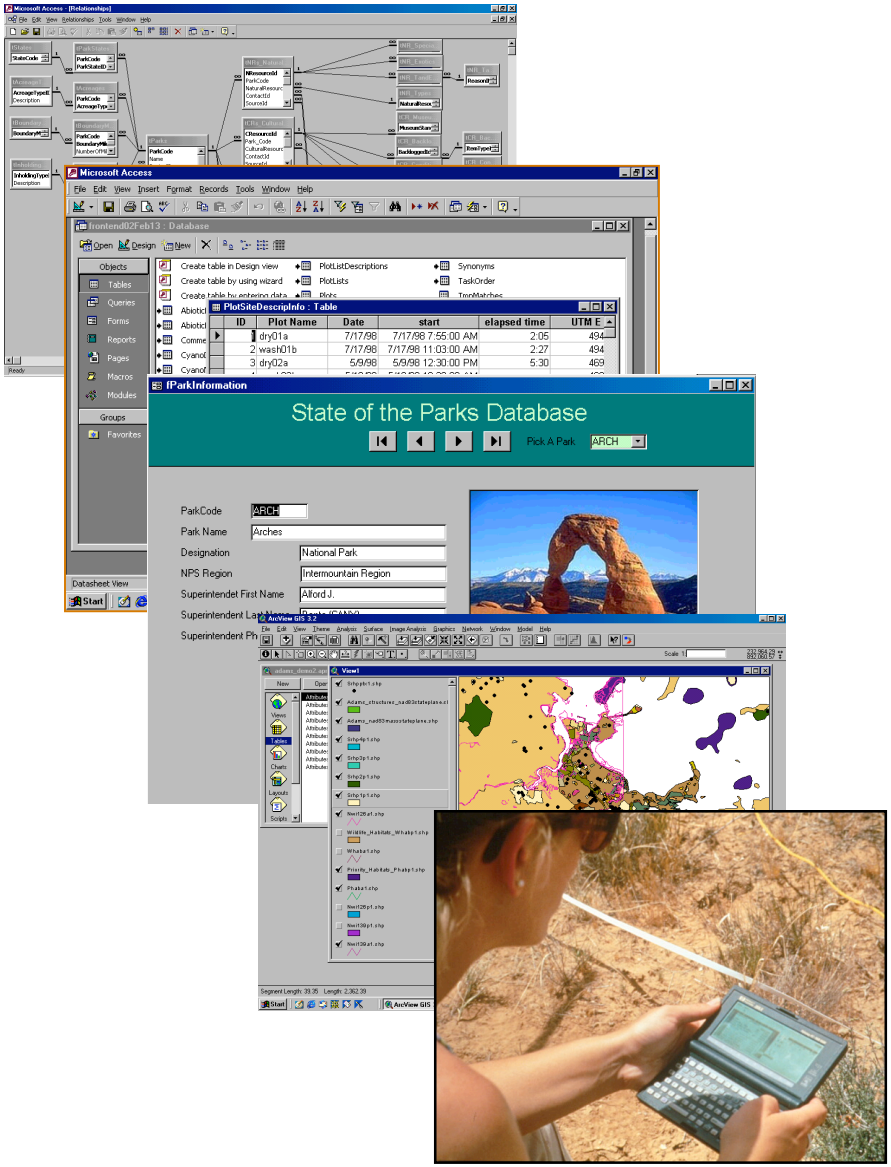


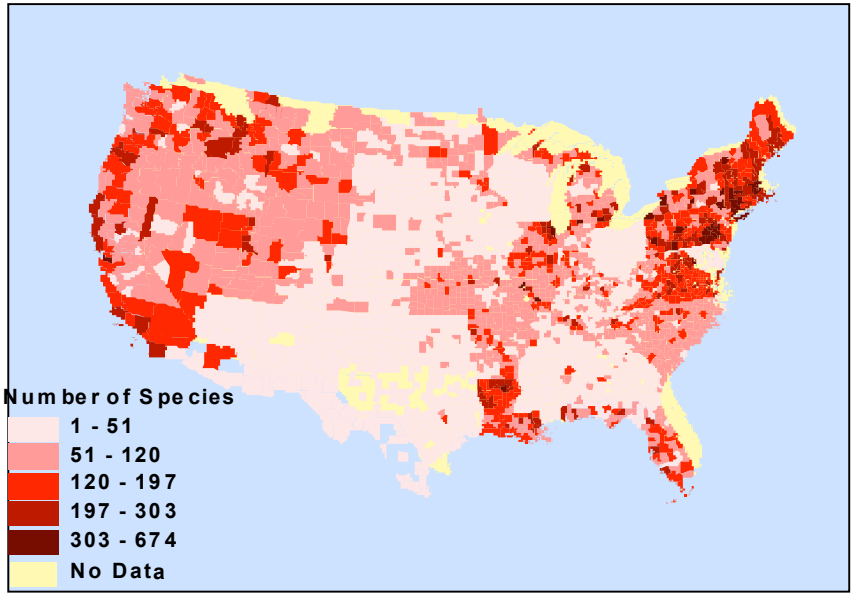
TOMS | Aqua/Terra | AERONET | ICESat | Aura | INTEX | CloudSat | CALIPSO | OCM | NPP/NPOESS | APS | GTCM*

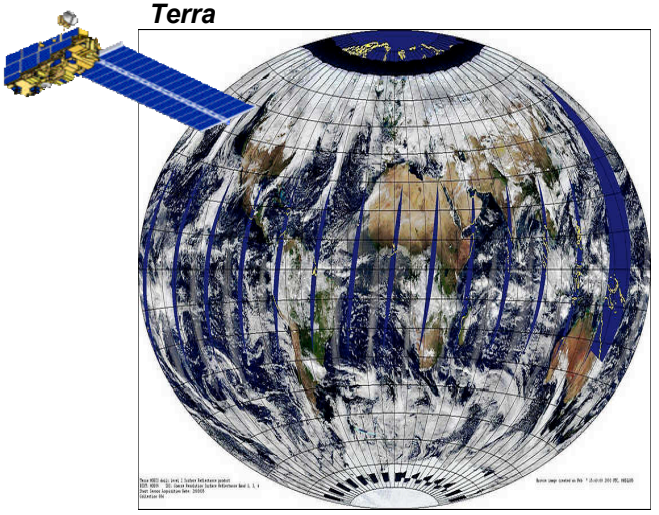
2003 2005 2007 2009 2011 2013 2015

* Unfunded

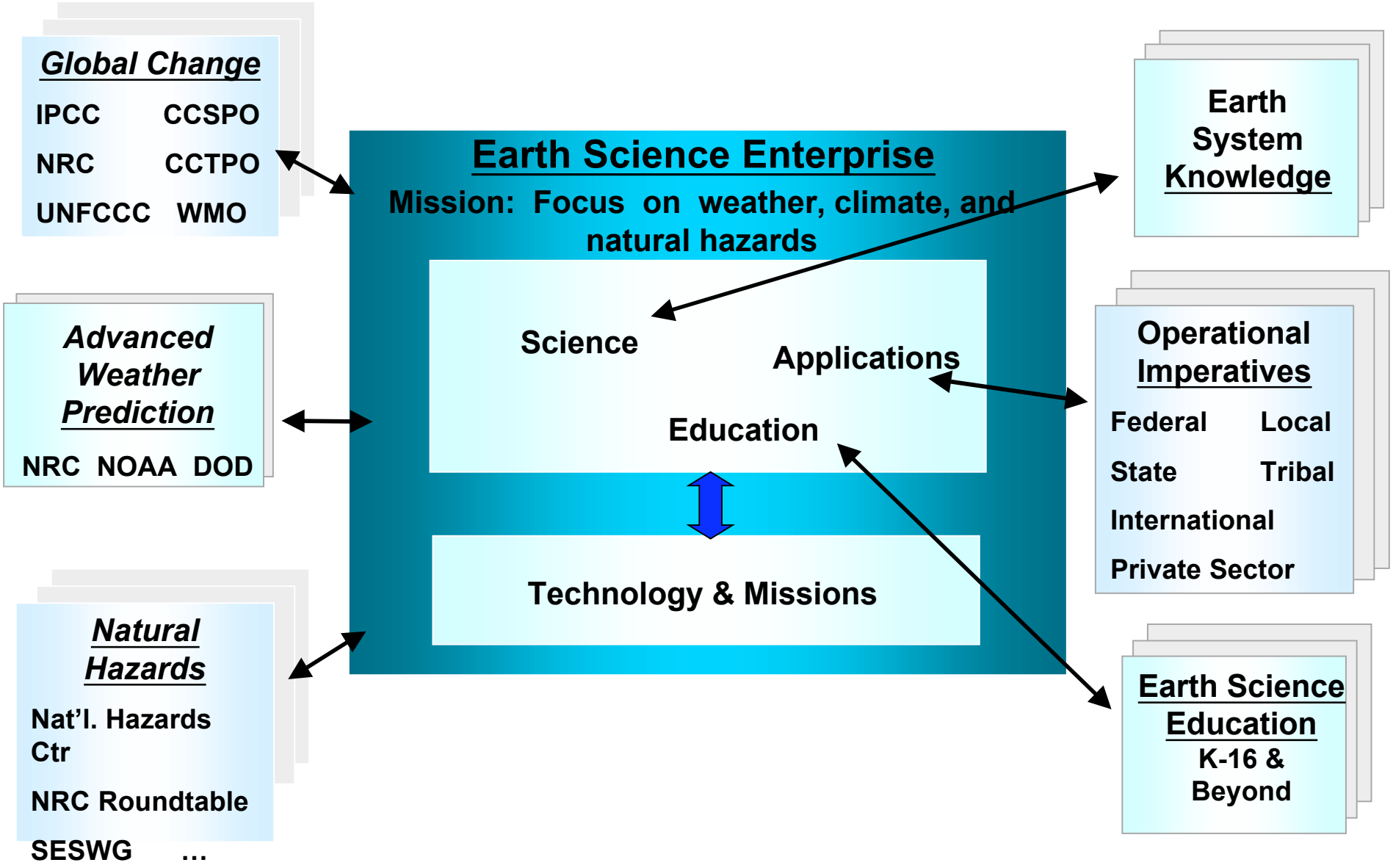
Improving Predictions of Invasive Species Risk







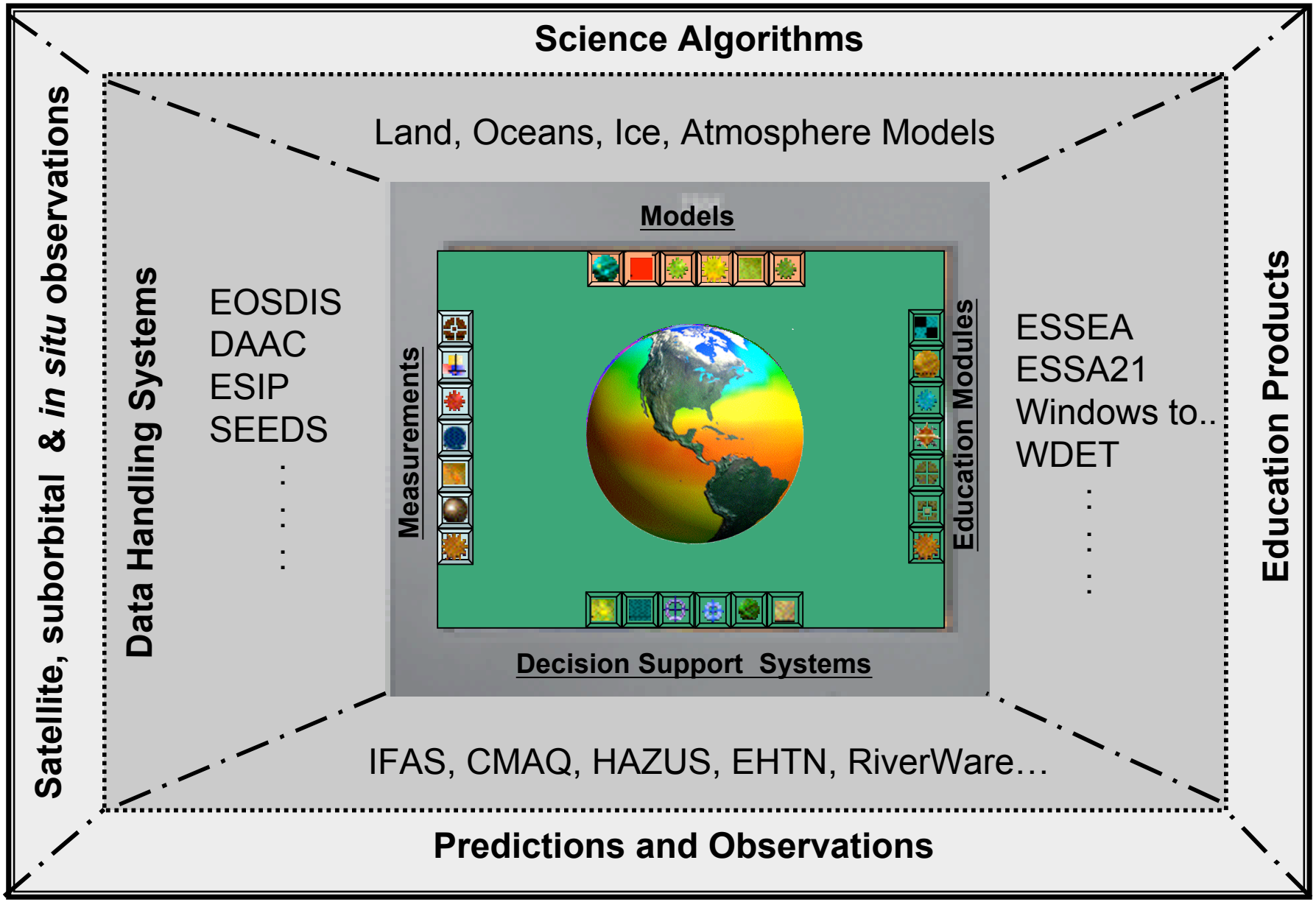
Beyond Science Research…serving Society



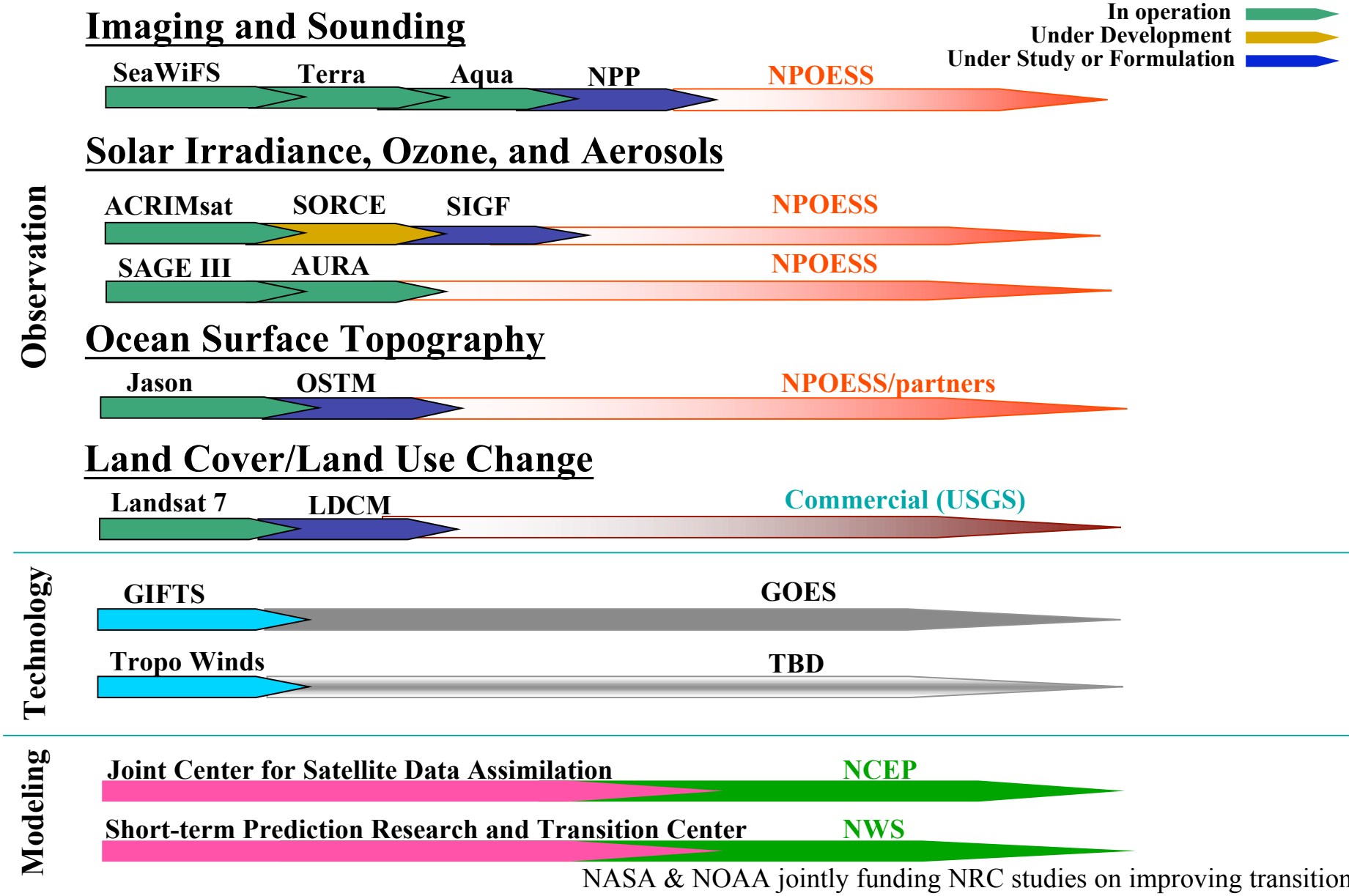
Primary Challenges

- Connecting to the institutional infrastructure of partnering agencies (national & international)
  - Geospatial One Stop, Federal Enterprise Architecture
- Establishing the framework for the transition from research to operational use of ESE observations and predictions …. with an emphasis on measurements with follow-on capabilities
  - NPP to NPOESS, Jason to OSTM, TRMM to GPM, LS7 to LDCM…)
- Focusing on integrated solutions that benchmark the assimilation of NASA results as inputs into specific decision support tools for policy management
  - Energy, Water, Air Quality, Coastal Inundation Scenario Assessment Tools

Connecting to Existing Infrastructure



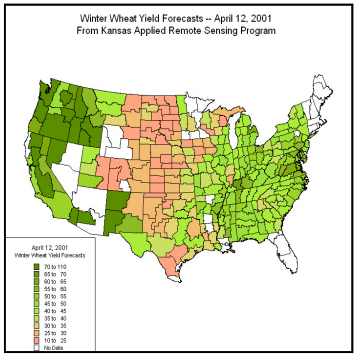
Transitioning from Research to Operations



NASA & NOAA jointly funding NRC studies on improving transition

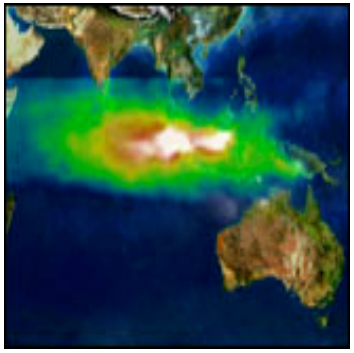
Integrating into Decision Support Systems

Agricultural:
Foreign Agriculture Forecast

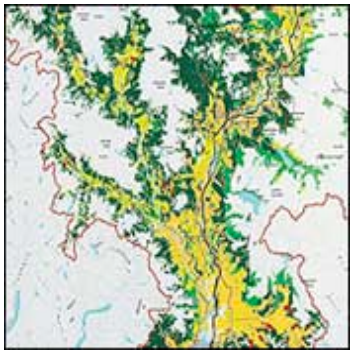


CCCSTI:
Carbon Management System

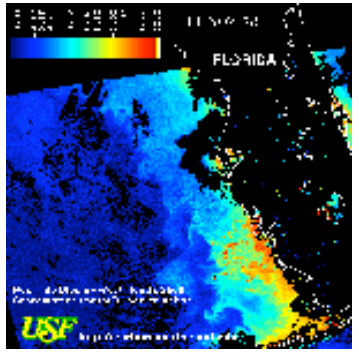
Invasive Species:
Prediction Center



Air Quality:
Community Air Quality



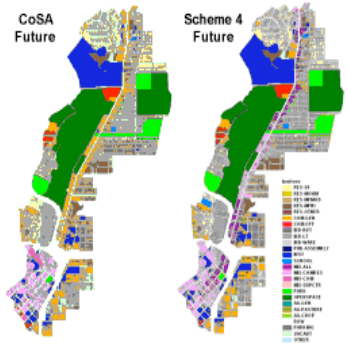
Water Management:
AWARDS, RiverWare



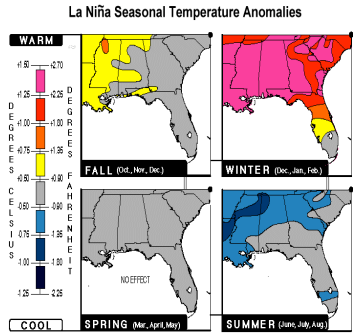
Coastal Management:
Harmful Algal Bloom Forecast

Decision Support Systems

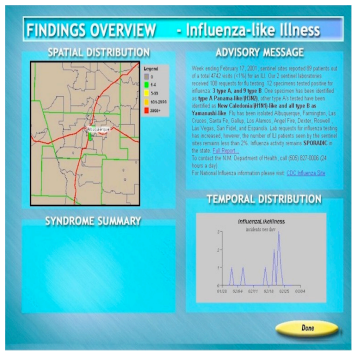
Aviation Safety:
National Airspace System



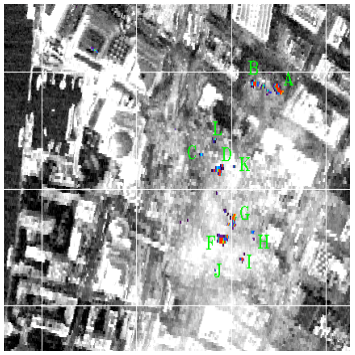
Community Growth:
Urban Dyanmics System



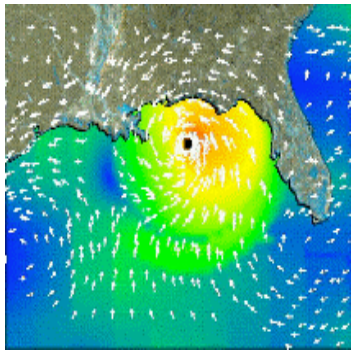
Energy Forecasting:
Renewable Energy System



Public Health:
Risk Assessment System



Homeland Security:
Situation Center



Disaster Preparedness:
HAZUS Risk Prediction

Secondary Challenges

- Establishing the network connections between the Earth Science Laboratories (and their model capacity to deliver improved predictions of weather, climate and natural hazards) and the partner organizations operating decision support tools
- Enabling the use of commercial remote sensing data for Earth science research in support of the President's Commercial Remote Sensing Policy

Earth Science Laboratories

GISS

JCSDA

Laboratory for Terrestrial Physics

Laboratory For Hydrospheric Processes

NASA Goddard Space Flight Center
LABORATORY FOR ATMOSPHERES

GHCC

SPoRT

GFDL
Geophysical Fluid Dynamics Laboratory
Princeton, NJ

National Centers for Environmental Prediction

ARL

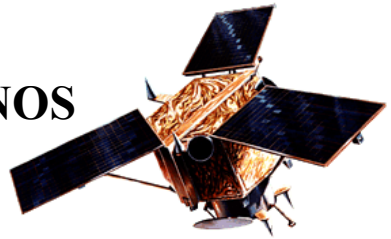
Office of Research and Applications

Data Assimilation Office

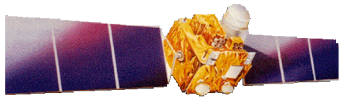
NCAR

Private Sector RS Systems

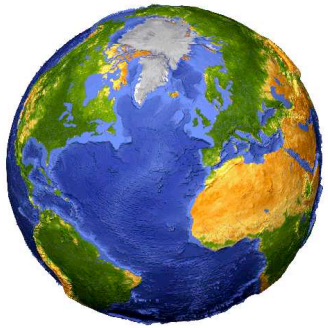
IKONOS

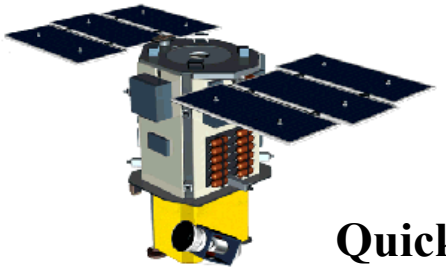


SPIN-2



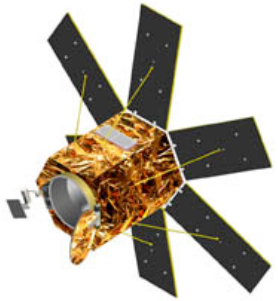
SPOT 4, 5





QuickBird

Orbview 3



EROS A1

Earth Science Enterprise Education Plan

NASA Mission:
To Inspire the Next Generation of Explorers

NASA 2003 Strategic Goal 6
Inspire and motivate students pursue careers in science, technology, engineering and mathematics (STEM).

NASA 2003 Strategic Goal 7
Engage the public in shaping and sharing the experience of exploration and discovery.

Earth Science Enterprise:
To Inspire the Next Generation of Earth Explorers

Earth Science Education Goal 1
Inspire and motivate students to pursue STEM careers relevant to Earth system science and Earth science applications and technology.

Earth Science Education Goal 2
Increase public scientific literacy of Earth system science and climate change by engaging the public in shaping and sharing the experience of NASA's exploration and discovery.

Education Status & Challenges

- Status
  - Effectively coordinating with Code N
  - GLOBE cooperative agreement
  - Hundreds of NIP, GFP awards
  - Hundreds of discrete education products
- Challenges
  - Develop and disseminate an Education Plan
  - Establish an architecture for systematic, sustainable, scalable development and delivery of Earth science knowledge to the education community

NASA Education Program Principles

Content: Programs and products are directly to or make direct use of NASA content, people or facilities to involve students and/or the public in NASA science, technology, engineering or mathematics.

Customer Focused: Programs and products respond to needs identified by the education community, a customer or customer group.

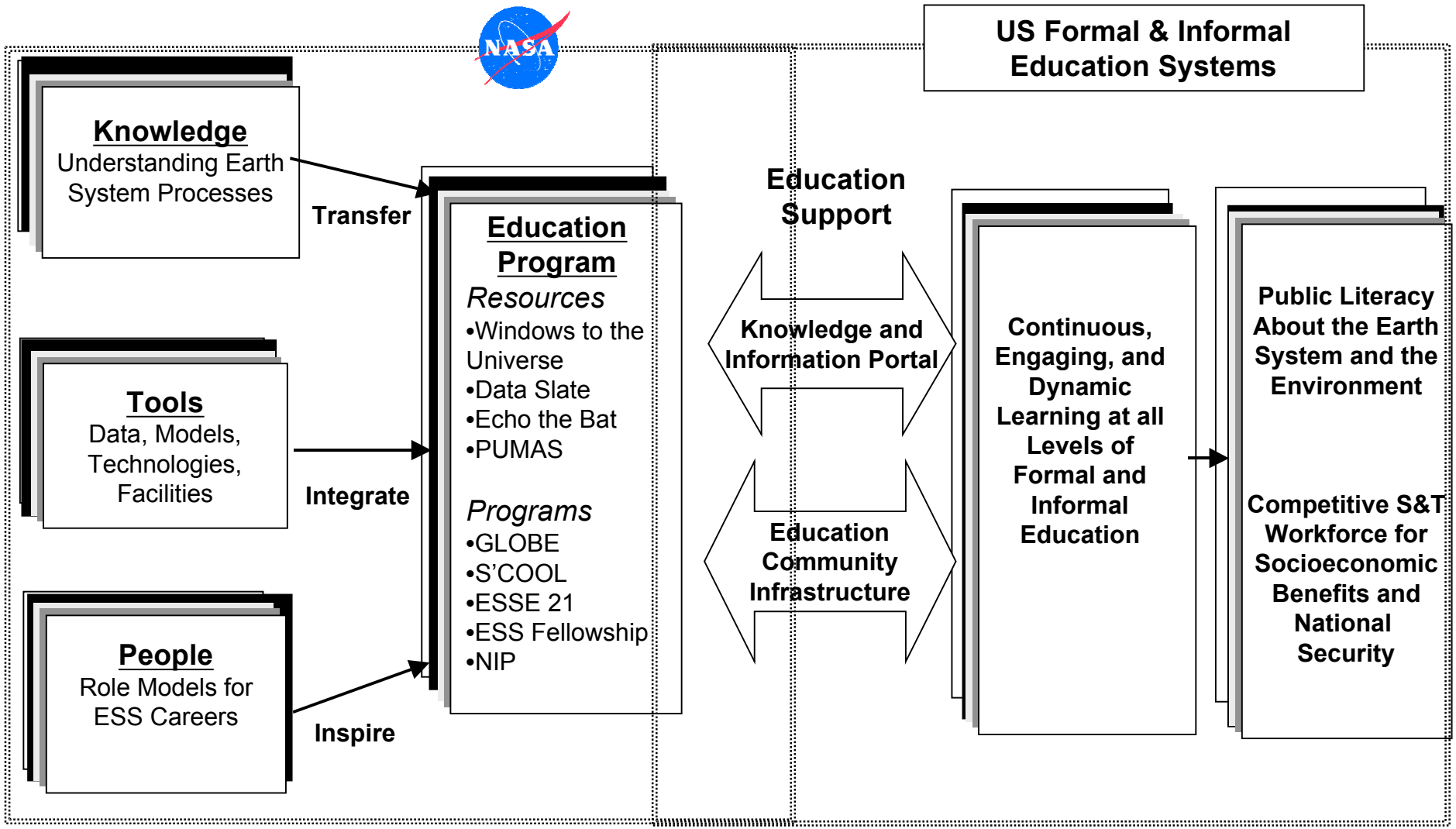
Pipeline: Programs and products attract diverse students to NASA careers in science, technology, engineering or mathematics.

Diversity: Programs and products reach identified targeted groups.

Evaluation: Programs and products have goals expressed in an objective, quantifiable, and measurable form,

Partnerships/Sustainability: Programs and products achieve high leverage and sustainability.

Architecture for Earth Science Education



Towards a National Infrastructure for Development & Dissemination of Earth Science Research Results into STEM Education

DRAFT

Dynamic, institutionalized product development and delivery system.

Learning About the Earth System

Competitive Science and Technology Workforce for Socioeconomic Benefit and National Security;
Public Literacy about the Earth System and Environment

Partners:
- Federal Agencies
- Education Administrations
- Universities and Colleges
- Education Resource Providers
- Professional Societies
- Private Industry
- Educator Networks

Full participation of ESE in NASA e-Education initiative → Impact: National infrastructure for widespread dissemination and use of ESE products and resources

Routine integration of ESE programs and resources into EKG and other Education Support Systems → Impact: ESE resources routinely used in STEM education

Simplified, web-based Earth system models driven by ESE data accessible to education community. → Impact: Increased use of scientific tools in education

Catalogue of ESS models and standardized metadata readily available. → Impact: Increased interdisciplinary research and education

ESE data sets interoperable and readily accessible through web-based interfaces (e.g. Open GIS Consortium) → Impact: STEM Education emphasizes current Earth system processes

Earth system science education research integrated into STEM education research base. → Impact: Innovative pedagogies and best practices used to deliver content

ESE education resources accessible through DLESE and other Education Support Systems → Impact: ESE data, models and resources dynamically integrated into STEM education

Standardized templates for all ESE resources → Impact: Demonstration of the applicability of ESE to STEM education.

Discrete resources and programs shared within specific communities and networks.

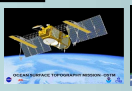
Current trajectory:
Steady improvement in the recognition of the applicability and use of ESE data, models and knowledge to STEM education

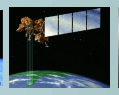

ICESat


Aura


CloudSat

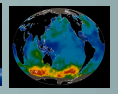

CALIPSO


OSTM


LDCM


OCO


APS


GPM


NPOESS

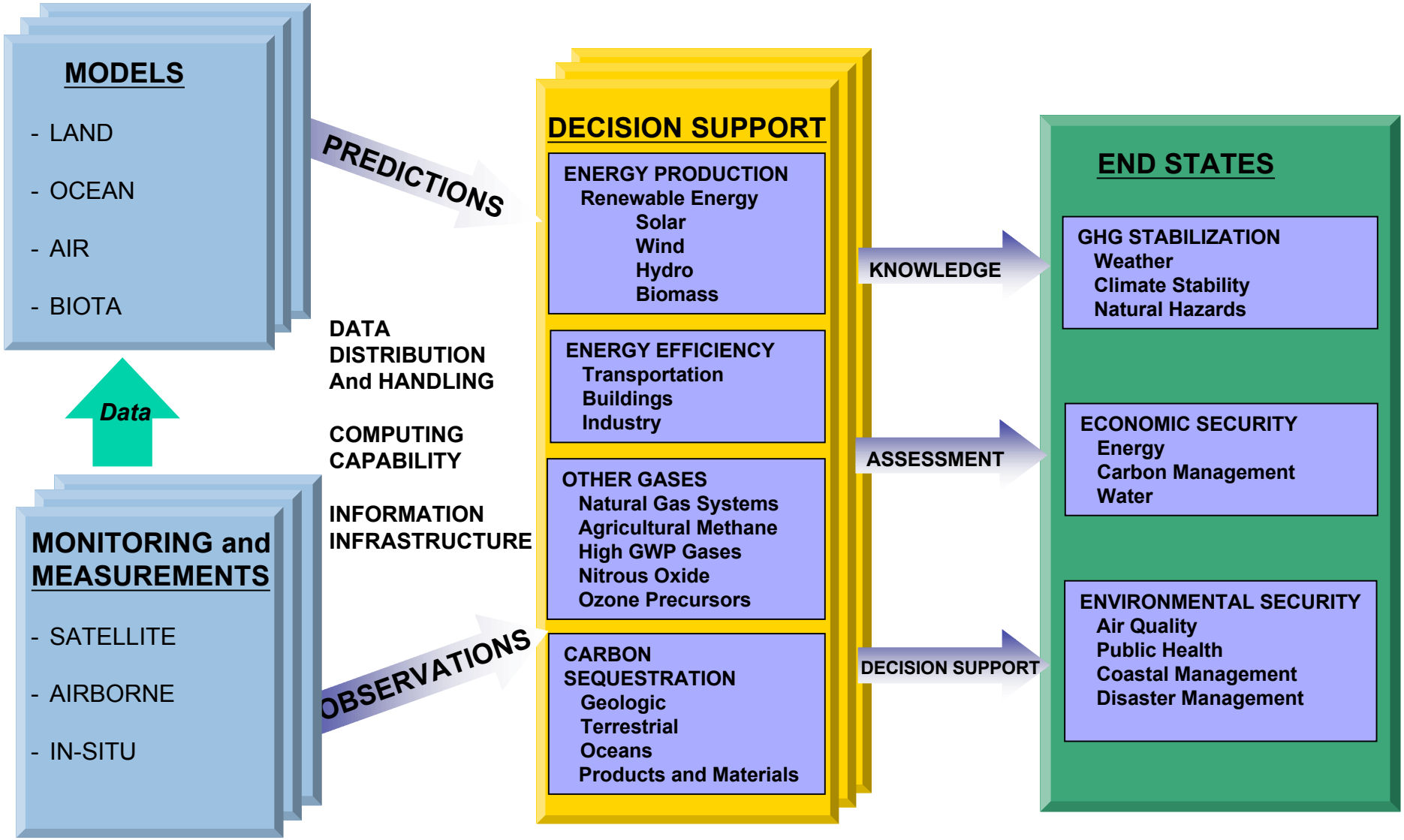

DSCOVR

2003 2005 2007 2009 2011 2013

Serving Administration Priorities

- G8 Summit (S&T priorities include Energy, Agriculture, and Earth Observations) – June 2 Press Release
- Earth Observations Summit – July 31, 2002
- Climate Change Technology Program 5-Year Strategy – planned for August, 2003
- Climate Change Science Program 10-year Strategy – released July 15, 2003
- Commercial Remote Sensing Policy – signed April 25, 2003
- Geospatial One Stop – Portal Release on June 30, 2003
- Federal Enterprise Architecture – coming soon

CCTP Monitoring & Measurements WG



Earth Observation Summit